Astronomy and Astrophysics 2013 vol.554

Planck intermediate results: X. Physics of the hot gas in the Coma cluster

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Abstract

We present an analysis of Planck satellite data on the Coma cluster observed via the Sunyaev-Zeldovich effect. Thanks to its great sensitivity, Planck is able, for the first time, to detect SZ emission up to r ≈ 3 × R500. We test previously proposed spherically symmetric models for the pressure distribution in clusters against the azimuthally averaged data. In particular, we find that the Arnaud et al. (2010, A&A, 517, A92) "universal" pressure profile does not fit Coma, and that their pressure profile for merging systems provides a reasonable fit to the data only at r < R500; by r = 2 × R500 it underestimates the observed y profile by a factor of â‰2. This may indicate that at these larger radii either: i) the cluster SZ emission is contaminated by unresolved SZ sources along the line of sight; or ii) the pressure profile of Coma is higher at r > R500 than the mean pressure profile predicted by the simulations used to constrain the models. The Planck image shows significant local steepening of the y profile in two regions about half a degree to the west and to the south-east of the cluster centre. These features are consistent with the presence of shock fronts at these radii, and indeed the western feature was previously noticed in the ROSAT PSPC mosaic as well as in the radio. Using Plancky profiles extracted from corresponding sectors we find pressure jumps of 4.9-0.2 +0.4 and 5.0-0.1 +1.3 in the west and south-east, respectively. Assuming Rankine-Hugoniot pressure jump conditions, we deduce that the shock waves should propagate with Mach number Mw = 2.03-0.04 +0.09 and Mse = 2.05-0.02 +0.25 in the west and south-east, respectively. Finally, we find that the y and radio-synchrotron signals are quasi-linearly correlated on Mpc scales, with small intrinsic scatter. This implies either that the energy density of cosmic-ray electrons is relatively constant throughout the cluster, or that the magnetic fields fall off much more slowly with radius than previously thought. © 2013 ESO.

http://dx.doi.org/10.1051/0004-6361/201220247

Keywords

Cosmic background radiation, Cosmology: observations, Galaxies: clusters: general, Galaxies: clusters: individual: Coma cluster, Galaxies: clusters: intracluster medium, X-rays: galaxies: clusters